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(57) Abstract

A feed made of fish meal, especially an enriched feed for use with edible animals (living feed), which are to be given to fry. The meal is micronised with a particle size which is adjusted in groups according to the size of the edible animal. The micronised meal can be mixed with fat and vitamins and can be homogenised with this. A soft dry feed is especially for use as weaning feed for fry at the transition from living feed to formulated feed. It consists of hard roe-like agglomerated particles, which are made of micronised fish meal, fat, bonding agent, vitamins and minerals. The feed has a water content of below 14 weight %.

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FEED AND PROCESS FOR PRODUCTION THEREOF.

The present invention relates to a feed made of fish meal and especially an enriched feed for edible animals (living fodder such as artemia craw fish and rotatoria, which are to be given to fry.

The invention relates further to soft dry feed, especially a weaning feed for use for fry at the transition from living feed to formulated feed.

In addition the invention relates to a process for producing the afore-mentioned feed.

The breeding of salmon and trout has gone on in Norway for many years, and such breeding has become a significant industry. In recent years there has also been interest in the breeding of types of marine fish, that is to say kinds of fish which can only live in sea water, such as halibut, turbot and cod. The problems with the feeding of larvae and fry of such kinds of marine fish are however substantially greater than the problems with the feeding of larvae and fry of salmon and trout.

Fry of halibut and other types of marine fish are fed the first time with edible animals, such as artemia craw fish and rotatoria. After a period oif feeding with living feed, one can go over to a formulated feed, which in the trade is often called "weaning" feed.

The enriched feed for edible animals is characterised by the features as evident from the characterising portion of claim 1. while the weaning feed for fry is characterised by the features as evident from the characterising portion of claim 6.

The process for the production of the enriched feed for the edible animals is characterised by the features as evident from claim 5, while the process for the production of the weaning feed for fry is characterised by the features as evident from claim 9.

In order to achieve the desired effects with enriched feed for use for artemia special attention must be given to the following factors:

a) micronising technique for,

b) particle size for, and

c) the quality of, that meal, which is to be micronised.

a) Micronising technique:

Fish meal is a medium which produces great wear in the working apparatus. A micronising technique, which is based on metallic crushing means breaking down the meal particles to less than 10 µm, can give unfortunate quality deterioration, such as metal contamination and heat damage to the product.

A metallic contamination will easily be able to give high concentrations of metals in the feed. In addition the metals will act pro-oxidisingly on fat and protein. Friction heat, which occurs locally at the contact surface between metal and meal will redily deteriorate the protein quality and/or oxidise the fat. Fat-protein-interactions are also unfortunate effects which can follow from the occurrence of contamination in combination with the occurrence of local friction heat.

The single commercial type of mill which at the moment can fulfill the requirements which must be set for the micronising, is the so-called jet mill or powder/powder collision mill (example: Alpines mill AFG). This technique of milling is based on compressed air or compressed nitrogen (if desired in combination with liquid nitrogen) getting the meal particles to collide with one another. In this way the danger of metal

contamination is reduced and in addition a supply of large quantities of expanding compressed air/nitrogen will prevent local heating of the powder.

b) The particle size:

Seven to eight hours before the feeding the edible animals, that is to say the living fodder, are supplied with enriched fodder in order to improve thereby the nutritional value of the fry. Micronised herring meal (fish meal) of high quality with an average particle size d_{50} - 7 µm and d_{99} = 25 µm has proved to be an excellent enriched fodder for artemia.

It was found that the quality of artemia craw fish became very good by the use of the micronised quality meal as enriched fodder.

Another important effect which was observed, was that the number of halibut fry with pigmentation deficiencies was insignificant on using craw fish which were enriched on the micronised meal. It was also found that the nutritional quality of the enriched feed had significance for the pigmentation. Furthermore it was found that the particles had to be sufficiently small in order that the nutritional quality should be utilisable.

c) The meal quality:

The quality of the meal has been found to be critical in order to be able to succeed with the enriched feed. Firstly the fish, which the meal is made of, must be fresh. The content of volatile nitrogen in the fish must therefore be less than 40 mgN/100 g.

Secondly the quality of the fish proteins must be preserved as far as possible during the production of the meal. This can be taken care of by preventing autolysis in the fish material before and during the production of the meal, and also by avoiding the occurrence of high temperatures at critical phases in the production process, something which will otherwise damage the protein.

A process which provides meal of satisfactory quality is charecterised by:

that the glue water, which becomes a part of the meal,

forms a gel when it is preserved, at +2 - +4°C,
that the water-soluble portion of the protein in the meal is set low,
that the content of the biogenous amines in the meal is set low
that the biological true digestibility of the meal is set high,
that the pH of the meal is set relatively high and
that the fat content of the meal is set low.

The elasticity of the particles of the meal increases with increasing fat content. In order that the micronising shall take place satisfactorily, the elasticity however must be sufficiently low. This means that the fat content of the meal ought not to be higher than 10%.

If the fish, which is to be employed as raw material, is given chances to autolyse before or during the production of the meal, this will involve a pH-reduction. Relatively high pH of the meal, that is to say pH of 6-7.5 and especially pH of 6.5-7, is therefore an indication of little autolysis, and that the protein build up in the meal is more like the starting point for the protein build up in the fish.

Is is also important that the proteins are not exposed to thermal damage during critical phases of the production process. Such damage reduces the biological digestibility of the protein. It is a known method for characterising the quality of the meal. A high quality value, that is to say a quality value higher than 92%, indicates little heat damage of the protein.

Types of marine fish which feed mainly on living feed, are very sensitive to biogenous amines. which represent bacterial decomposition products from amino acids. Consequently the content of biogenous amines will give an indicatiion of autolytic and bacterial decomposition of the proteins before and during the production of the meal. The content of each of the biogenous amines histamine, putrescine and tyramine ought not to exceed 0.04 g/1kg meal while the content of cadavarine ought not to be above 0.4 g/kg meal.

How much of the protein of the meal, which is soluble in water, is also an indication of the degree of autolysis, or proteolytic activity, before and during production of the meal. Low content of water-soluble components in the feed gives less leakage of feed, better utilisation of feed, and therefore less environmental load on the breeding installation. The content of water-soluble protein in the meal from whole fish is considered to be low, when it is less than 25%.

A further indication of a low degree of autolysis during the fish meal process is the consistency of the glue water. If the glue water forms a gel by cooling it down towards +2 to +4C, this means that the binding proteins (collagens) of the fish are preserved through the boiling process. Glue water, which forms such a gel on cooling down, constitutes an important ingredient during the production of the soft dry feed.

The necessity of good protein quality is based on that it would appear as if certain types of larvae and fry must absorb at an early stage a portion of proteins directly for intracellular conversion. In other words they are not in a condition to break down the proteins to smaller peptides and amino acids in digestive tracts in order to build them up again. This can possibly explain that the halibut fry must be fed on edible animals the first time.

When halibut fry or other marine types are to be weaned from feeding with edible animals at the fry stage, specific requirements must be placed on the weaning feed, particularly from the type and development stage. That is to say the weaning feed ought to have the correct content of protein, fat and carbohydrate, have a correct mineral and vitamin content, have a suitable particle size, and the particles ought to be soft and free of sharp particles, which can damage the digestive system. Furthermore the particles ought to retain their shape during feeding, give the desired low leakage to the surroundings and have a satisfactory speed of sinking.

With the starting point in the enriched feed a soft dry feed was produced, which saisfied the afore-mentioned requirements.

The feed consisted of the following ingredients:

a) micronised meal of corresponding type and quality as was employed for the enriched feed,

b) marine fat (cod liver oil and fish oils) or marine fat combined with vegetable fat,

c) vitamins and minerals,

d) glue water concentrate of high quality (is gel-forming in the region +4 to +2°C).

Tests were also made by mixing taste attractants, without this having a negative effect on the feed production.

With these ingredients several types of soft dry feed were produced containing less than 12 weight % water, without carbohydrates, and in the form of hard roe-like particles of 0.2 - 1.5 mm magnitude.

Experimentally one found that the fat content in the feed could be varied freely in the region 15-35%. Furthermore it was found that when only raw fish oil is employed, the content of free fatty acids ought to be lower than 1.5%.

The feed retained its shape in the breeding vessels and gave little leakage to the surroundings (10-20 weight % after 30 minutes in water).

From the experiments made it was demonstrated that halibut fry in two breeding installations clearly preferred this feed over commercial "weaning" feed.

During the feeding the halibut fry snapped at the soft dry feed immediately, in contrast to commercial "weaning" feed which was spat out again several times before the halibut fry finally managed to swallow it.

In order to achieve the desired particle form and softness there was employed a so-called agglomerating technique. It involves smaller particles being built up into larger particles by means of cutting forces and bonding agents which are either supplied separately or which are present in the particles/powder.

Factors which have signifiance if one is to succeed with the agglomerating technique are as follows:

- Particle size and form for the primary particle versus the

agglomerated particle

- Which bonding agents which are naturally present, or which must be supplied to the particles during the agglomerating
- How and with which strength the cutting forces are supplied to the powder material which is to be agglomerated.

Of known agglomerating methods rotating plates, rotating knives, and air/gas-whirling up technique (fluidising) can be mentioned.

The most important supposition is that the choice of mode of micronising, particle size and quality of meal and glue water concentration, together with necessary amount of fat, yields an agglomerateable material, without the addition of foreign substances. This is achieved by preserving the natural collagens of the fish through the fish meal process.

Tests demonstrate that the agglomerated soft dry feed is reformable after mechanical loading. Deformation of the soft feed by pressure only required that one undertook a little stirring of the powder material, whereby the hard roe-like agglomerates were reformed.

The agglomerating technique functions better the finer the meal was micronised. It has been shown that powder with an average particle size, d_{50}, of over 50 µm gave poorer agglomeration.

The advantages of using the soft dry feed, for example as weaning feed, can be summed up as follows:

- The halibut fry preferred the soft dry feed over commercial feed in experiments undertaken with two different breeders. Subsequent drying, which is necessary when using known feed products, yields harder particles, together with the danger of oxidising and/or interaction between fat and proteins. The soft dry feed on the other hand need not be subseqently dried.
- The survival and the quality of the halibut fry proved to be very good with the breeder which employed the soft dry feed as "weaning" feed. The high survival achieved by halibut fry must be attributed to the quality of the feed. There were

no sharp bone particles in the feed, something which otherwise could damage the digestive system of the fry, and this can be one of the reasons for the high degree of survival.

- The feed included no carbohydrates.
- The fat becamse mixed into the feed at low temperatures. With this the danger of the fat-protein interaction and oxidising could be reduced significantly.

It is important that the particle or particles, which the fry consume, must include the right nutrients substances. Viewed statistically an agglomerated particle of a finemicronised meal will include a richer selection of nutrients than a chance meal particle having the size of the agglomerate. Both types of particle will displace the same volume in the digestive system of the fry. The volume of the digestive system defines the feed intake of the fish fry.

CLAIMS.

1. Feed made of fish meal, especially enriched feed for use with edible animals (living feed such as artemia craw fish and rotatoria which are to be given to fry, characterised in

a) that the meal is micronised with a maximum particle size (d_{max}) of 25 µm and average particle size (d_{50}) of below 10 µm for the smallest edible animals,

a (d_{max}) of 150 µm and (d_{50}) of about 25 µm for somewhat larger edible animals, and

a (d_{max}) and (d_{50} of 200 µm and 50 µm for the largest edible animals, and also

b) that the micronised meal is mixed if desired with fat and vitamins and is homogenised with this.

2. Feed in accordance with claim 1, characterised in

that the meal is made of fresh fish, where the content of volatile nitrogen is less than 40 mgN/100 g.

3. Feed in accordance with claim 1 or 2, characterised in

that the meal is added to glue water which forms a gel when it is kept at +2 to +4°C,

that the content of water-soluble protein of the meal is low (less than 25%),

that the content of biogenous amines of the meal is low (content of histamine, putrescine and tyramine is at the highest 0.04 g/kg meal and of cadaverine at the highest 0.4 g/kg meal), and

that the pH of the meal is relatively high (6-7.5, preferably 6.5-7).

4. Feed in accordance with one of the claims 1-3, characterised in

that the protein in the meal is made without thermal damage in order to ensure that the biological true digestibility of the protein is high (preferably higher than 92%).

5. Process for the production of feed made of fish meal, especially enriched feed for use with edible animals (living feed, such as artemia craw fish and rotatoria) which are to be given to fry, characterised in

that a fish meal is employed which has a fat content of at the highest 10 weight %, and

that the meal is ground (is micronised) in an apparatus, such as a powder-powder collison mill, which produces little heat development and which produces little or no metal contamination, after which the product obtained if desired is mixed with fat and vitamins and is homogenised with this.

6. Soft dry feed, especially for use as weaning feed ("weaning" feed) for fry at the transition from living feed to formulated feed, characterised in

that it consists of hard roe-like agglomerated particles, which are made of micronised fish meal having a particle size (d_{50}) of below 50 µm, fat in an amount of 15-35 weight %, bonding agent, and also if desired vitamins and minerals, and that the feed has a water content of less than 14 weight %.

7. Soft dry feed in accordance with claim 6, characterised in that it has a particle size of 0.2 - 1.5 mm.

8. Soft dry feed in accordance with one of the claims 6-8, characterised in

that the bonding agent is in the form of a glue water concentrate which forms a gel on cooling down to a temperature in the region from +2°C to +4°C.

9. Process for the production of dry feed for use as weaning feed ("weaning" feed) for fry, at the transition from living feed to formulated feed, characterised in

that fish meal, preferably on the basis of the meal which is employed in the enriched feed according to claim 1, having a particle size of less than 50 µm, is mixed with fat and bonding agent and also possibly vitamins and minerals and is exposed to cutting forces to form agglomerates in the form of hard roe-like particles.

INTERNATIONAL SEARCH REPORT

International Application No PCT/NO 92/00043

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[5]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: A 23 K 1/18

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	A 23 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	DE, A1, 2903448 (UNILEVER N.V.) 7 August 1980, see page 17, line 18 - page 18, line 28 --	1,5,6,9
X	EP, A2, 0292052 (SUOMEN SOKERI OY) 23 November 1988, see page 3, line 49 - line 53; claims 1,8 --	1,5,6,9
A	NO, B, 156814 (AKVA A/S) 27 April 1987, see page 1, line 9 - line 16 --	1,5,6,9

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12th June 1992	1992 -06- 23
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Inga-Karin Petersson Inga-Karin Petersson

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/NO 92/00043

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 2903448	80-08-07	NONE	
EP-A2- 0292052	88-11-23	JP-A- 1005455	89-01-10
NO-B- 156814	87-04-27	NONE	